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March 17-19, 2003

Houston, Texas

Energy Efficiency in the
Chemical and Refining Industries

Rohm and Haas Texas Inc.

Tour Guide Book
Deer Park Plant

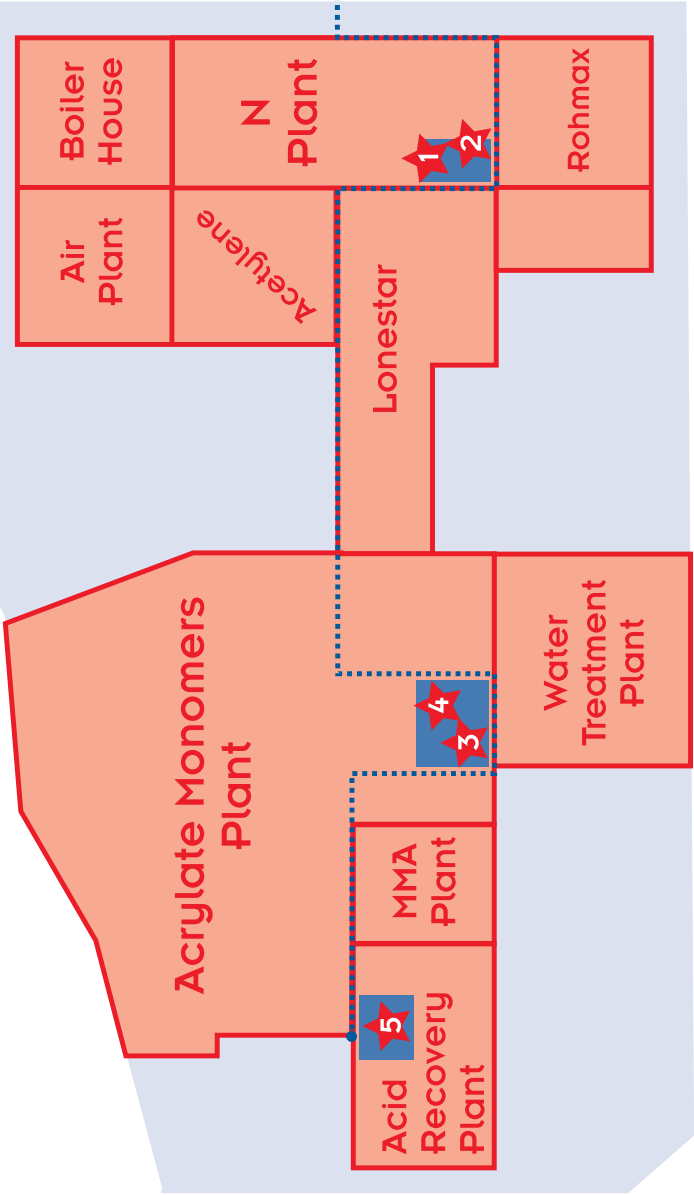
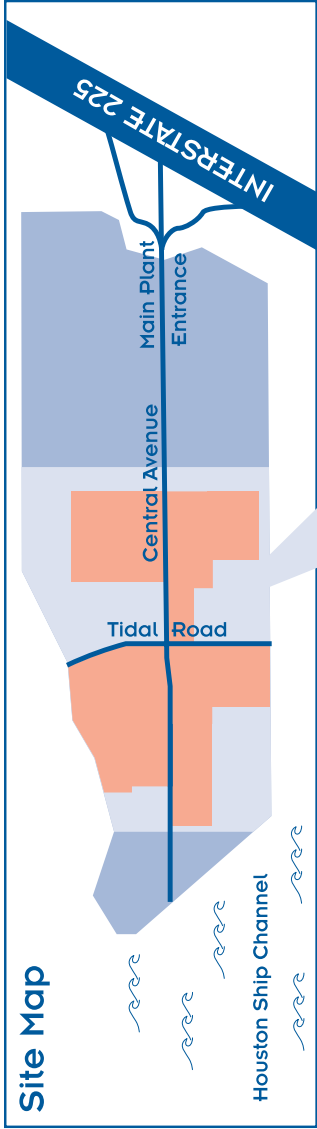


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Tour Route



Technology Tour Stops (TS)

Plant-Wide Energy Management Program Benefits	
TS1	★ 1 Flare System Improvements ★ 2 Refrigeration System Improvements
TS2	★ 3 Thermal Oxidizer Optimization ★ 4 Improved Efficiency of Cooling Tower Pump
TS3	★ 5 Acid Plant Furnace Optimization
Plant-Wide Optimization of Plant Steam System	
Plant-Wide Steam Trap and Leak Repair Program	

Bus Route
● Begin at Plant Entrance

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Plant Overview

Rohm and Haas Texas Inc.

Deer Park, Texas

Rohm and Haas Company is one of the world's largest manufacturers of specialty materials, including adhesives, sealants, coatings, monomers, electronic materials, inorganic and specialty solutions, and ion exchange resins. Founded in 1909 by two German entrepreneurs, Rohm and Haas has grown to approximately \$6 billion in annual revenues.

Rohm and Haas Texas Inc. occupies 900 acres along the Houston Ship Channel in Deer Park, Texas, approximately 22 miles east of downtown Houston. Constructed in 1947, the facility is Rohm and Haas' largest plant globally, employing nearly 800 workers. The plant consists of eight production areas that operate as separate facilities, or "plants within a plant." The myriad of specialty chemicals manufactured at the site include methyl methacrylate, acrylic acid, amines, and various acrylates. Though seldom seen by consumers, these chemicals enable other industries to produce better-performing, higher-quality end products and finished goods for consumers worldwide. Some of the markets using specialty chemicals from Rohm and Haas Texas include paints, detergents, floor care products, adhesives and sealants, automotive coatings, acrylic plastics, personal care products, and water purification chemicals.

The Deer Park facility accounts for about a third of Rohm and Haas' global energy requirement. In 1997, the plant created a formal Energy Management Program to reduce energy consumption. In just five years, the program has reduced energy intensity by 23.3% per pound of production. The program uses internal and external audits and assessments to identify opportunities for energy efficiency improvements. Of the 150 opportunities identified to date, over 50 have been implemented. A real-time, plant-wide energy management optimization system known as Visual MESA® was also installed to better understand, control, and optimize the entire facility's energy use.

A variety of organizations have recognized the plant's energy, environmental, and safety efforts:

- U.S. Department of Energy Plant-of-the-Year Runner-up (2001).
- Industrial Energy Technology Conference Energy Conference Award (2001).
- Texas Governor's Environmental Excellence Award for Large Industrial Facilities (2001, finalist in 1997).
- American Chemistry Council's Region 1 Responsible Care Gold Award (2002).
- Texas Chemical Council's Caring for Texas Award (2002).
- Office of Safety and Health (OSHA) Voluntary Protection Program (VPP) Merit (1997).
- OSHA VPP Star (2000) and OSHA VPP Star Among Stars (2000).
- National Petroleum Refiners Association Award for Meritorious Safety Performance (1999).
- Texas Chemical Council's Distinguished Service Award for Safety Performance (2002).



Aerial Photograph of Deer Park Facility

Energy Management Program Benefits

Case Study

Effective energy management is essential to cost-effective plant operations, especially in large facilities with annual energy bills totaling many millions of dollars. Improving the way energy is used throughout the plant can lower production costs, reduce air emissions from fuel combustion, and enhance profitability. Optimizing energy use in a highly complex chemical plant, however, can be technically challenging. It requires efficient integration of many different energy sources and end-uses, proper sizing and maintenance of a wide array of energy conversion systems, and effective use of by-product energy.

Rohm and Haas Texas Inc., located in Deer Park, Texas, is Rohm and Haas Company's largest plant globally with an annual nameplate capacity exceeding 2 billion pounds. The plant is the company's primary source of monomers used in key Rohm and Haas products worldwide. Energy cost savings achieved at the plant are leveraged throughout Rohm and Haas' supply chain to provide value to customers. The plant is comprised of several production areas that operate with a high degree of autonomy as *plants within a plant* (PWPs). Energy optimization among these PWPs is complicated by their high levels of process energy and utility integration, production independence, and by-product energy generation.

In 1997, a review of the Deer Park cost structure identified energy use as a major opportunity. Recognizing that improved energy efficiency would simultaneously lower energy costs, reduce emissions, and support the company's emerging sustainable development initiative, the company created a formal Energy Management Program. The program is responsible for leveraging these energy-based opportunities to improve the company's competitive position.

Benefits

- 23% reduction in energy intensity.
- Over \$18.5 million in cost savings.
- 440 tons of NO_x emissions avoided annually.
- Reduction in greenhouse gas emissions (CO₂) of roughly 67,000 tons per year.
- Supportive of Sustainable Development.

The Energy Management Program Team

Deer Park's Energy Management Program Team includes PWP representation, broad engineering expertise (utility, power, project, electrical), and energy management skills. The team's mission is to identify, evaluate, develop, recommend, and champion a strategic energy program that delivers the lowest long-term production costs to the Deer Park plant. Through its activities, the team strives to facilitate a change in the plant culture and establish energy management as an ongoing and essential element of manufacturing and design excellence.

The Energy Management Program Team helps establish annual energy savings targets that are consistent with the business, then works with plant personnel to develop potential project ideas. The team meets with plant, PWP, and technical management personnel periodically to ensure proper program alignment and resources. Senior management is actively involved and fully supports the program, both of which are critical factors for success.



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Energy Management Strategy

As a first step, the team developed tactical and strategic plans to deliver and sustain long-term energy improvements. The team's strategy emphasizes implementation of short-term projects that provide immediate cost savings,

generate positive feedback to support the program, and deliver energy changes consistent with the long-term strategic energy direction. The team's near-term goals promote energy efficiency projects with the quickest return on investment, while its long-term goals require a longer implementation period to achieve substantial benefits.

Energy Management Program Strategic Goals

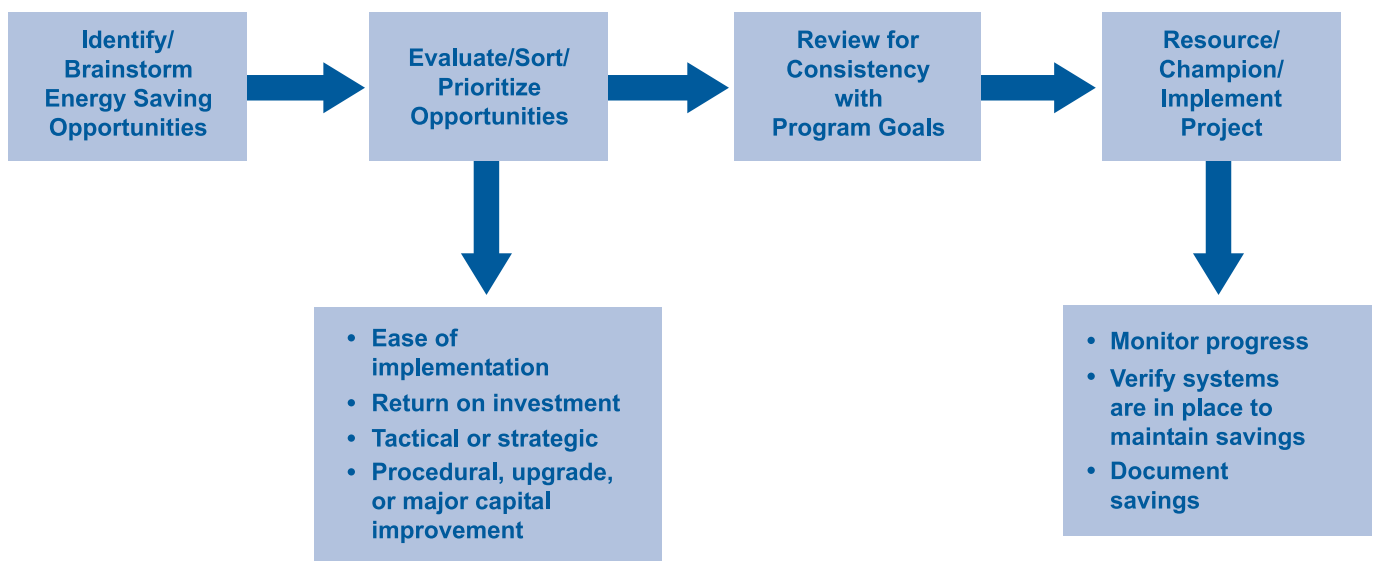
Near-Term Goals

- Recommend/champion energy-saving opportunities at the plant and process level.
- Develop, maintain, and communicate key metrics to track progress toward goals.
- Report progress to stakeholders to assure deliverables are aligned with business requirements.
- Decrease energy and utility budgeted usage each year to meet forecasted reductions.
- Maintain database of energy and utility cost improvement opportunities.

Long-Term Goals

- Develop and maintain sufficient knowledge of plant energy systems to enable proper technical and financial analyses of energy opportunities.
- Recommend a real-time, plant-wide energy management system with energy cost information and optimization information.
- Shift the plant utility cost distribution systems from a set percentage allocation to actual usage.
- Promote energy and utility efficiency initiatives in PWPs.
 - Facilitate energy and utility education and training.
 - Provide a technical forum that addresses plant utility and energy issues.
 - Establish benchmarks where logical and feasible.

Figure 1: Team Approach to Energy Project Selection and Implementation



As shown in Figure 1, the team's comprehensive approach begins with brainstorming new ideas and follows each project through completion and verification. All new projects are entered into a database and tracked through implementation and completion. Projects are evaluated, sorted, and prioritized according to a set of technical, financial, and strategic criteria. Tactical projects, for example, are defined as short-term, stand-alone projects that can be quickly implemented. Strategic projects are dependent on other projects or require greater technical evaluation. Projects are further classified as procedural changes, upgrades or modifications to existing systems, or major capital projects. Critical success factors are based on past plant experience, energy seminars, and input from energy agencies and other companies.

Once projects have been completed and are operational, the results are documented to provide verification of energy and cost savings over time. To date, the team has identified over 150 projects and has seen more than 50 implemented since 1997.

Energy Audit and Assessments

Deer Park's Energy Management Program relies heavily on energy audits and assessments to identify opportunities to improve energy efficiency. Both internal staff and external, independent auditors conduct these assessments, which target critical processes and unit operations that offer the greatest promise for energy improvements. The most recent activities performed under the direction of the Energy Management Program Team include a low-pressure steam audit, plant-wide pinch assessment, and a third steam system leak and trap survey. Many audits such as these have generated clear and expert recommendations for energy improvements at the Deer Park plant.

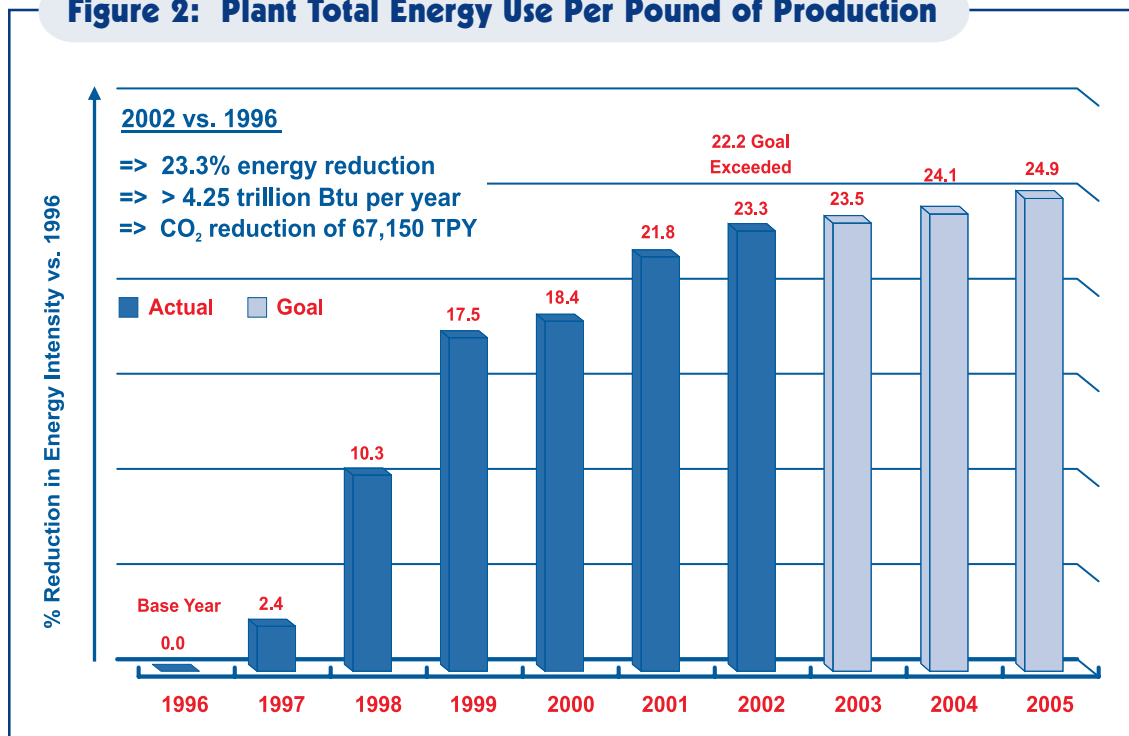
Energy, Environmental, and Economic Benefits

Through its Energy Management Program, the Deer Park plant has significantly improved the energy efficiency of its production processes and equipment. Direct results include a substantial reduction in energy intensity (energy use per production volume), energy costs, and air emissions, as shown in Table 1. The results clearly prove the triple sustainability win (energy, environment, economics) possible with an effective energy management program.

In addition, several of the energy-saving successes at the Deer Park plant can be replicated at other Rohm and Haas facilities. Since its inception, the program has reduced energy intensity by over 23%, as shown in Figure 2. To date, the program has saved the company over \$18.5 million annually in avoided energy costs.

Overall, a major achievement of the Energy Management Program has been to foster a corporate culture that values energy management as an indispensable element of manufacturing excellence. At the Deer Park plant, energy optimization is now factored into the plant's business strategy and manufacturing processes.

Table 1. Energy and Cost Savings	
Energy	<ul style="list-style-type: none">Reduced energy intensity (consumption per pound of production) 23.3% since 1996; more than 4.25 trillion Btu saved in 2002 (typical energy use for about 42,000 U.S. homes).Achieved more than a 15% energy intensity reduction in the 2-year period from 1997 to 1999.Achievement of 2005 plant energy reduction goals (15% energy intensity reduction) by 1999.Reduced energy intensity over 4% in 2001, despite almost a 7% decrease in production.
Economics	<ul style="list-style-type: none">2002's demand-side cost savings exceeded \$18.5 million.Avoided energy and utilities costs from program's supply-side activities of over \$10 million in 2002.
Environment	<ul style="list-style-type: none">Avoided on-site NO_x emissions of over 440 tons per year.Reduction in carbon dioxide (greenhouse gas) emissions by roughly 67,150 tons per year or about the same as removing 32,700 cars from the streets, roughly 1.8 cars for each Rohm and Haas employee worldwide.

Figure 2: Plant Total Energy Use Per Pound of Production

Key Elements of Success

The Energy Management Program at the Deer Park facility represents a forward-looking approach to energy efficiency by plant management and reflects successful teamwork.

Key elements to the success of this program include the following:

- An effective collaborative framework that involves appropriate plant personnel (at all levels) in project selection, evaluation, and decision-making.
- Involvement and financial support by senior management.
- Empowerment of plant personnel (financially and officially) to carry out the energy management mission.
- A highly effective core team to champion the Energy Management Program.

Flare System Improvements

The Deer Park site uses nine low-Btu flare systems to eliminate waste gases. Environmental regulations for flare systems (40 CFR 60.18) require that low-Btu waste gases be enriched with natural gas to the level of 200 Btu per scf prior to flaring. To meet this requirement, Deer Park had to add over 400 billion Btu of natural gas to its low-Btu flares in 1997.

Most of the flares used at Deer Park are John Zink® low-Btu flares with integral rimfire burners that preheat waste gases for more efficient destruction. Four of the flare systems are cross-connected to allow the flares to serve different operating units. Over the past several years, the plant has implemented various strategies to optimize these flare systems and reduce natural gas use.

Use of Hydrogen By-Product Stream

Deer Park's Acetone Cyanohydrin (ACH) Unit produces a by-product fuel containing hydrogen, which is normally used in the plant's boilers. The ACH area also has two flares that abate low-Btu gas streams. One of these flares requires approximately 55,000 scf per hour of natural gas enrichment to meet the 200 Btu-per-scf requirement. On occasion, plant personnel detected ammonia odors from the flare plume.

In response, plant engineers increased flare enrichment well beyond the 200 Btu-per-scf requirement for odor control. In 1998, the 40 CFR 60.18 rules were amended to allow low-Btu streams containing 8% or more hydrogen by volume to be flared without natural gas enrichment. In 1999, the plant applied for and received approval from the Texas Council on Environmental Quality (TNRCC at the time) to co-feed the hydrogen-containing by-product stream to the flare and discontinue use of natural gas enrichment¹. Since implementing hydrogen enrichment, Deer Park has realized savings in natural gas costs while receiving no odor complaints.

¹ Details of this new operating method are described in Patent Application EP 1158243.

Benefits

- Reduction in natural gas use by 90 MMBtu per hour.
- NO_x reduction of 27 tons per year.
- CO reduction of 55 tons per year.

Reduction in Rimfire Gas

The plant has reduced natural gas to the rimfire burners on all of the flares. In some cases, the actual rimfire gas flow rate was well in excess of the design value because pressure regulator settings crept higher over the years. Reducing rimfire gas in the plant's flares is conservatively estimated to have reduced natural gas use by 10 MMBtu per hour.

Optimization of Cross-Connected Flares

The plant area with four cross-connected flare systems has cut its consumption of natural gas through a combination of activities. Monitoring of flare costs helped to identify some of the potential energy-saving opportunities. The flares are all installed parallel to various thermal oxidizers. When a thermal oxidizer is out of service, the waste gases are diverted to the flare. Planning and coordinating unit outages has resulted in much higher thermal oxidizer utilization and lower flaring time. For example, when one oxidizer is down for a planned outage, instead of sending the waste gases to the flare, the gases are redirected to another thermal oxidizer.



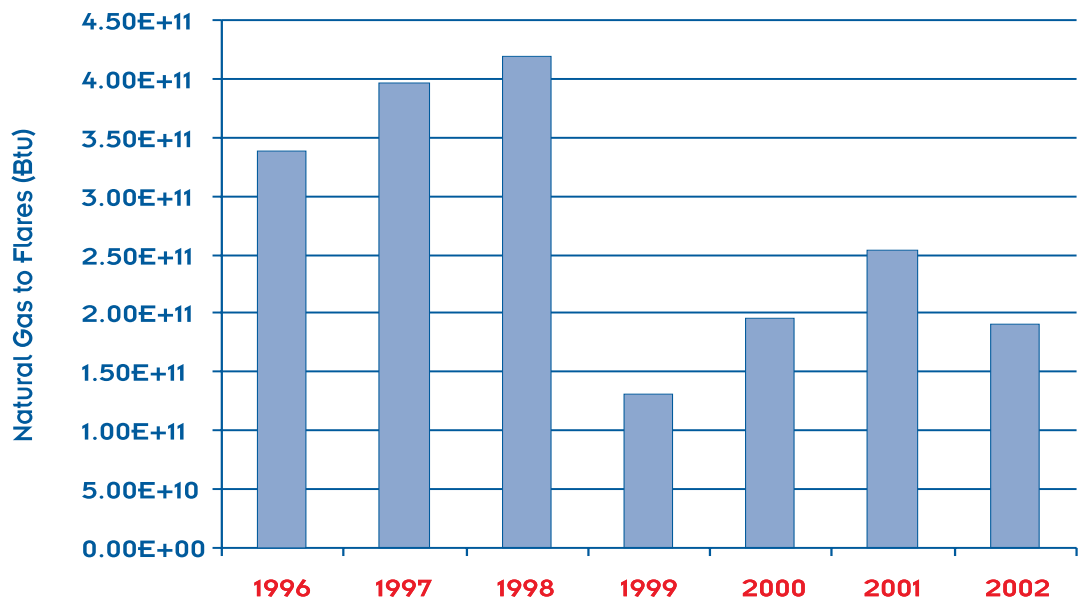
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In addition, improvements to the analyzer maintenance program and instrument system reliability have resulted in fewer trips by the oxidizer. As an example, redundant field devices have been added to avoid oxidizer downtime caused by instrument problems. Figure 1 illustrates the reduction in natural gas consumption achieved in these four flares since 1996, despite the start up of a new unit in 2000.

Figure 1: Natural Gas Consumption in Cross-Connected Flare Systems Since 1996



Refrigeration System Improvements

The Deer Park site uses refrigerated water at 41°F to provide process cooling for the manufacture of acetone cyanohydrin, distilled methyl methacrylate (MMA), and several smaller processes. The original refrigeration system for these processes was large, complex, and outdated, generating high maintenance and energy costs. The system consisted of six engine-driven reciprocating compressors using ammonia as the refrigerant. All of the condensers and evaporators were connected in parallel as one large system so that any failure of the pressure boundary had the potential to release a large amount of ammonia. In addition, when cooling tower water exceeded 87°F, the system was unable to maintain the desired cold water temperatures.

The refrigerated water circulation system was an open-loop system requiring 450 hp along with additional booster pumps in parts of the system. The jacket water system required additional pumping capacity and heat exchangers to reject engine heat to the cooling tower. In addition, oil from the reciprocating compressor would collect in the evaporator receiver and required daily purging to the wastewater and flare system, resulting in large losses of ammonia to the flare and oil to the waste treatment plant. The refrigeration system required a dedicated around-the-clock operator.

Replacement System

The original refrigeration system was completely replaced in 1997 with two 2,800-ton, open-drive, motor-driven, York centrifugal compressor systems using 134a refrigerant. The two machines allow for 100% installed spare capacity and provide a much more efficient refrigeration system. The chiller systems are fully automated, including start-up

Benefits

- \$110,000 per year reduction in ammonia and oil losses.
- \$300,000 per year reduction in energy costs.
- \$650,000 per year reduction in operations and maintenance costs.
- 70 tons per year reduction in NO_x.
- Reduction in CO emissions.
- Avoided end-of-life replacement costs of \$3 million.
- Improved production quality and capacity.

sequencing, and only require manual water balancing prior to start-up. The evaporators have internally and externally enhanced copper-nickel tubes, while the condenser tubing is externally enhanced copper nickel. Normal operation produces 11,000 gallons per minute of 41°F refrigerated water at a load of 2,600 tons. Efficiencies at this load range between 0.45 kW per ton and 0.68 kW per ton depending on cooling tower water temperature. The refrigerated water circulation system has been converted to a closed-loop system and the booster pumps removed from service to reduce the pump energy requirement.



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Savings

The new system avoids the risks inherent in handling ammonia. Purging of oil to waste treatment as well as losses of ammonia to the flare have been eliminated, resulting in an annual material cost savings of \$110,000. Energy consumption has decreased significantly, with savings totaling approximately \$300,000 annually. The system is fully automated and much simpler, reducing annual operations and maintenance costs by \$650,000. The replacement of gas engines with electric motors and the lowered energy use have reduced NO_x and CO emissions.

The facility saved an estimated \$3 million in equipment replacement costs. Production quality and capacity have also improved with the colder and more consistent water flows.

Figure 1: Old Ammonia Refrigeration Condensers



Figure 2: New 134a Refrigeration System



Thermal Oxidizer Optimization

The Deer Park site operates several thermal oxidizer (TO) systems with heat recovery steam generators to safely dispose of waste vapors and liquids. The plant has been working to optimize the fuel efficiency and energy recovery or utilization of these systems. To date, TO optimization efforts have yielded energy savings valued at over \$1.6 million annually. Continuing optimization efforts are projected to provide an additional \$2 million annually by 2005.

Improved Fuel Efficiency

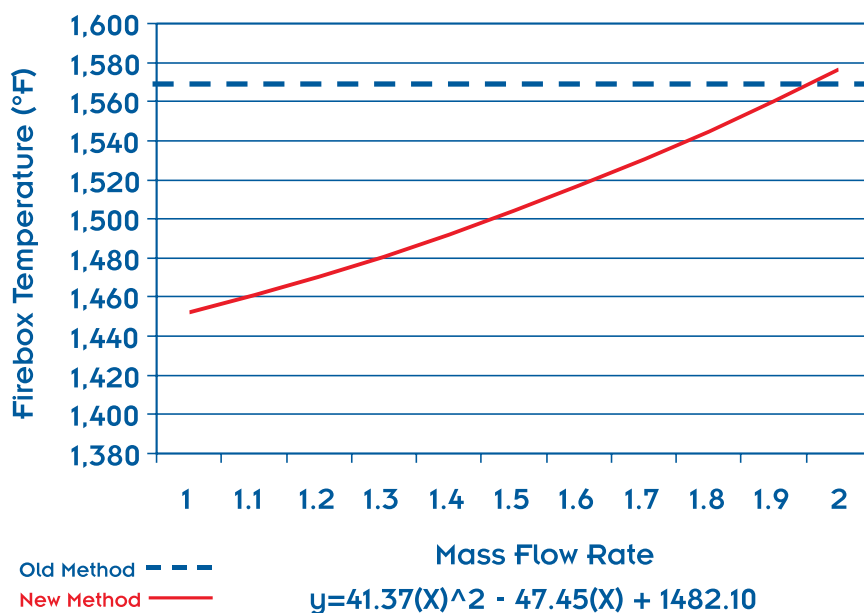
One fuel efficiency project involved rewriting the TO temperature control algorithms to better maintain the required firebox temperature. In addition, methods were developed and proven to allow plant operators to vary the firebox temperature as a function of waste feed rates rather than maintaining one fixed-temperature setpoint. After approval by the Texas Commission on Environmental Quality (TCEQ), implementation of the new methods allowed for a decrease in natural gas rates to the TO¹. The reduction in firebox temperature has produced fuel savings of over \$600,000 annually. Figure 1 shows the new operating temperature of the TO firebox as a function of mass flow rate and indicates the old fixed-temperature control setpoint.

Demonstrating that lower excess oxygen levels would not reduce the efficiency with which the TO destroys VOCs also led to improved fuel efficiency. Once the correct operating parameters were verified, plant operators were able to reduce the excess oxygen concentration in the stack, resulting in fuel savings of \$400,000 annually.

Benefits

- Fuel savings of over \$1.6 million annually.
- Thermal efficiency improvement from 78% to 84% in heat recovery system.
- 9 MM Btu per hour reduction in stack heat losses.
- Reduced vibration levels due to better flue gas flow arrangement.
- Additional steam production valued at \$470,000 a year.

Figure 1: Operating Temperature of the Thermal Oxidizer as a Function of Mass



¹ Details of this control methodology can be found in U.S. Patent No. 6499412B2



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Improved Heat Recovery

In 1999, plant engineers at the Deer Park site installed several new heat exchange systems to reduce fuel consumption and improve thermal efficiency. With these heat exchangers, the plant now uses waste heat to preheat various feed streams to the TO, providing about \$600,000 in annual fuel savings. A new superheater is providing higher superheat temperatures and relieving a steam pressure-drop problem that was limiting the boiler's ability to export steam at high rates.

Increased Heat Recovery from Thermal Oxidizer Stack Gas

The original TO heat recovery system was installed in 1989 when gas prices were under \$2 per million Btu. With increasing fuel prices and an aging system, the Deer Park site decided to evaluate "like for like" replacements for potential operability, reliability, and energy efficiency improvements. Plant engineers considered several options for recovery of waste heat from the flue stack gas, including a larger economizer, feedwater heating, and air preheat.

The option selected as the most efficient consists of two economizers (see Figure 2), one serving the thermal oxidizer boiler system and the other serving two separate, nearby waste heat boilers. The system, which has been operating successfully since early 2002, allows for increased steam generation by each boiler for a given heat input. Additional steam production savings of \$470,000 per year have been realized. Simple payback for the project is less than two years. Despite an increase in heat transfer area, the improved flow configuration has also reduced vibration levels and gas-side pressure drops.

Figure 2: New Dual Economizer for Thermal Oxidizer



Improved Efficiency of Acrylates Area Cooling Tower Pumps

In 1998, the plant engineers at the Deer Park facility initiated a project to increase the hydraulic pumping efficiency of one of the cooling tower systems in the acrylates area. As part of this effort, the DOE performed a pump assessment in 1999 using the Pumping System Assessment Tool (PSAT). The PSAT software helps industrial users assess the efficiency of pumping systems and calculate potential energy and cost savings. Based on comparisons to achievable pump performance standards from the Hydraulic Institute and motor performance data from the DOE's MotorMaster+ database, the PSAT identified the pumping system for the acrylates area cooling tower as an area for potential energy savings.

Cooling Tower Pump System

The acrylates area cooling tower contains four single-stage, vertical turbine pumps, with three pumps on-line during normal operation. Each pump has a design capacity of 25,000 gallons per minute (gpm) at 120 feet of total dynamic head (TDH), with a pump curve efficiency of 80%. Measured efficiencies were found to be much lower due to pump wear.

The pump impellers typically operate for approximately three years before their performance degrades. Cooling tower flow was measured and found to be considerably below the design capacity. A subsequent inspection of the pumps indicated that two of the pump impellers showed significant wear, partially explaining the low flow levels. In the past, flow measurements of other specific equipment supplied by the tower also indicated performance was below original design rates. An increase in pump TDH could potentially deliver the required flow rates. Plant engineers proposed a

Benefits

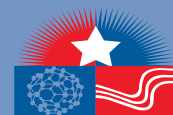
- Energy cost savings of \$70,000 per year.
- Increased pumping capacity for the cooling tower and planned expansions.

new pump system to move flow rates toward the design level and reduce energy use. The new pump will achieve between 87% and 88% hydraulic efficiency in the range of 23,000 to 27,000 gpm with a TDH between 120 and 130 feet—a significant improvement. The new pump consists of an impeller and bowl assembly capable of delivering an additional 1,000 gpm with a higher TDH.

Figure 1: Cooling Tower Pumps for the Acrylates Area



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System Savings

The new system delivers more flow capacity while using less energy. The electrical energy cost savings totals \$70,000 annually for normal three-pump operation. With the additional 1,000 gpm of flow and higher pump head, a small increase in circulation rates has also been possible (~3,000 gpm total). This increase has allowed the cooling tower to achieve the desired design flow rate. The extra capacity, in turn, allows equipment supplied by the tower to operate at design conditions. The new pumps were installed during 2000 and 2001; a validated performance test to verify savings has not yet been performed. Field measurements indicate increased flows and higher system pressures with a decrease in pump amps. In fact, the acrylates area is now able to run on two pumps instead of three for most of the year.

Acid Plant Furnace Optimization

The Deer Park site operates multiple sulfuric acid recovery plants to handle the large quantities of spent sulfuric acid generated during production of methyl methacrylate (MMA). The acid recovery process is energy intensive and uses large-volume, high-temperature furnaces that are fired with natural gas. The spent acid must be injected into the furnaces and decomposed to permit recovery of the sulfur-containing portions of the waste stream. As shown in Figure 1, the plant has implemented a number of improvements to reduce energy consumption in these furnaces.

Reduction of Atomizing Air Compression Energy

The spent acid stream contains large amounts of water that must be atomized (broken into many small droplets) during injection into the furnace to promote rapid evaporation and decomposition. The original furnace design used multiple spinning-cup atomizers, with each furnace requiring 1,000 hp to compress the air needed for atomization. Over the years, these spinning-cup atomizers experienced continuous maintenance problems due to corrosion and mechanical issues. The plant has experimented with various alternatives, such as external airblast and internal premix atomizers, to find a more viable solution.

In 1998, plant engineers installed a custom-engineered, BETE® two-fluid atomizer nozzle with an internal pre-atomizer¹. This atomizer technology creates smaller droplets when the liquid stream is sprayed into the furnace and uses one-third less air. The smaller drop size allows for lower furnace temperatures without affecting evaporation and decomposition times. Lower furnace temperatures have reduced the amount of natural gas required to fuel the furnace.

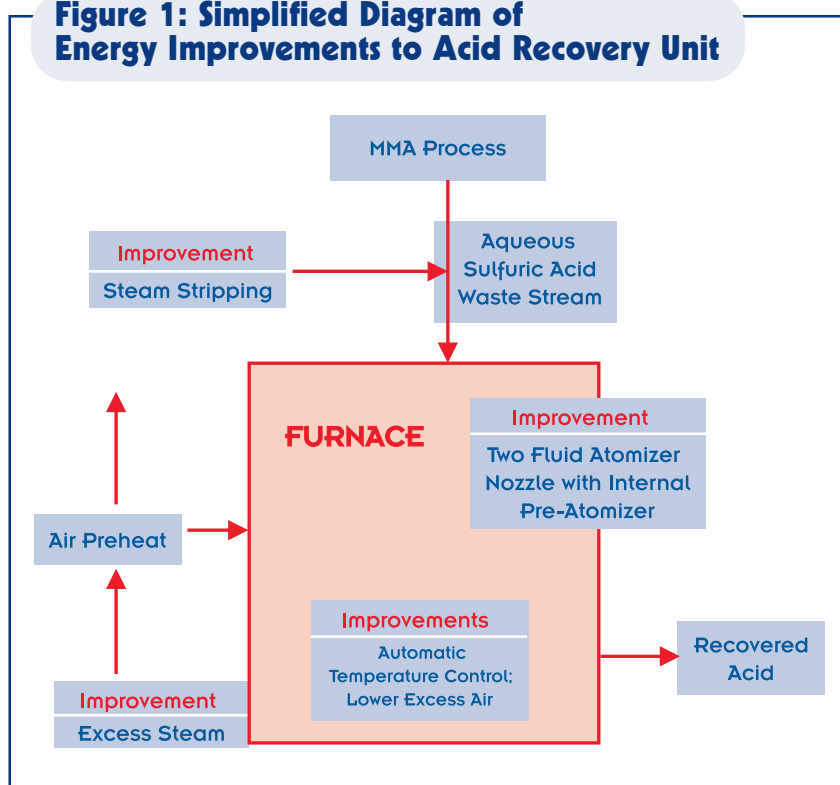
¹Application of this atomizer technology for recovering sulfur compounds from a spent sulfuric acid stream is detailed in U.S. Patent No. 6,399,040.

Benefits

- Cost savings of over \$3 million per year in reduced electrical and natural gas costs.
- Productive use of low-pressure excess steam.
- More consistent control of furnace temperatures.

The improved atomization technology has produced an overall cost savings of \$1 million annually. These savings include avoided natural gas and electricity costs as well as reductions in maintenance costs.

Figure 1: Simplified Diagram of Energy Improvements to Acid Recovery Unit



Preheating Combustion Air with Excess Steam

Combustion air for the acid recovery furnace is typically preheated by an indirect, natural gas-fired air heater. During furnace optimization efforts, plant engineers determined that the plant often has excess low-pressure steam (150 psig) in close proximity to the spent acid recovery units. To take advantage of this heat source, engineers installed a 150-pound steam coil to heat the incoming air for the furnace air preheater. The result is a 15% reduction in natural gas required to fire the air preheater.

Reducing Water Content of Spent Acid

To further optimize the spent acid units, the plant is now performing additional steam stripping of the spent acid residue prior to feeding it to the furnace. This step has significantly reduced the amount of water fed to the furnace, decreased the amount of liquid that must be atomized, and lowered natural gas consumption.

Reducing Excess Oxygen

Operating the furnace with lower excess oxygen levels (now possible with the two-fluid atomizer) has reduced energy use. Lower excess oxygen reduces the amount of incoming air that must be heated, resulting in lower energy requirements.

Figure 2: Sulfuric Acid Furnace



Automatic Temperature Control

Historically, temperatures in the spent acid furnace have been shown to oscillate by as much as 25°C under typical operating conditions. These oscillations can cause inconsistent and sometimes inefficient use of energy. To reduce the degree of oscillation, the plant implemented a feed-forward, automated control algorithm that allows plant operators to maintain furnace temperatures within a couple of degrees of the setpoint. The result is more uniform furnace operation and an overall reduction in natural gas consumption.

Optimization of Plant Steam Systems

The Deer Park plant site covers 900 acres and is subdivided into eight independently operating areas. Steam systems are essential to all operating areas, which are connected through common steam lines with various pressure levels (see Figure 1). Total steam generation ranges from 1 to 2 million pounds per hour.

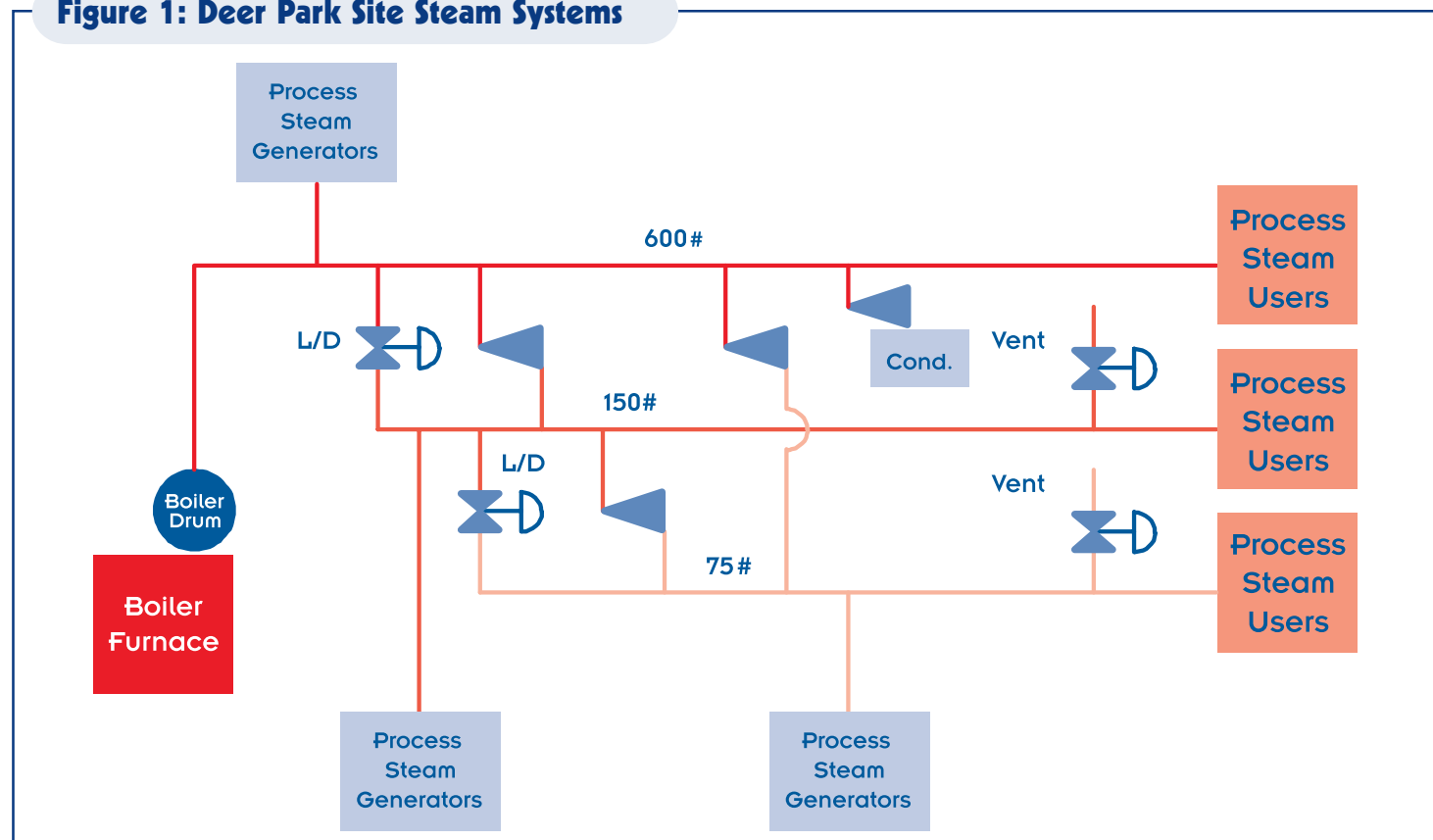
Managing and optimizing this steam infrastructure is a challenging task. The plant has 11 low-pressure steam systems and uses steam turbines for many pumps, fans, and compressors. The plant has one gas turbine with a heat recovery steam generator and over 20 waste heat and utility steam boilers. Waste heat steam production varies with unit production rates, and maintaining steam system pressure balance is a continuous effort.

Benefits

- Optimization of steam system operation.
- Training and education of plant personnel in steam-system operation.
- Real-time input on steam system parameters.

The Deer Park plant began using Visual MESA® (Modular Energy System Analyzer) to monitor and optimize plant-wide steam system operation in mid 2000. Visual MESA is a program designed for steam system monitoring, modeling,

Figure 1: Deer Park Site Steam Systems



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optimizing, auditing, and accounting. The program employs a graphical user interface to display real-time data for steam, boiler feed water, and condensate systems, and is used at refineries and chemical plants across the country.

Visual MESA® Optimization Program

At the Deer Park site, Visual MESA resides on a stand-alone server and is accessible from any desktop within the company. The optimizer is run hourly, and a small team of plant engineers reviews the recommendations. The team takes into account equipment status and known, near-term production changes that may affect steam balance; recommended changes are implemented as appropriate.

The model has proven to be an excellent tool for training and educating plant personnel on the complex steam system. The real-time model with graphics of the entire plant shows operators and engineers the “big picture” of the steam system, including impacts that individual units exert on the overall balance. One-click trending of key steam system parameters allows for easy confirmation of the benefits or costs associated with certain operating decisions. “What if” scenarios help in the planning of various unit shutdowns for annual maintenance.

The system allows for determination of metering mass balance errors, which helps identify meters that need correction. This feature allows for better internal accounting of steam. The metering mass balances are a necessary part of the optimization process. They are important for quantifying errors after simulation with real-time data and before the SQP (sequential quadratic programming) optimization methodology is applied.

Following the development of the Visual MESA model for use at the Deer Park site, plant engineers made several basic changes to equipment operating philosophy to improve plant efficiency. The program continues to serve as an important tool for facilitating the efficient management and operation of plant-wide steam systems.

Steam Trap and Leak Repair Program

Steam Trap Auditing and Repair

The Rohm and Haas Deer Park site generates 1 to 2 million pounds of steam per hour for use in essential plant operations. The plant's extensive steam systems range in age from less than one year to over fifty years and include over 2,000 steam traps. Leaks from these traps can be a considerable source of energy loss and increased operating costs. In 1999, a plant-wide steam audit at the Deer Park site identified steam trap leaks and other opportunities for reducing energy losses. The audit revealed steam losses of approximately 92,000 pounds per hour, immediately precipitating a project to make a large number of repairs in a short time frame. The plant initiated a capital project outside of routine maintenance efforts to repair leaks and failing traps.

Following the initial repair effort, Rohm and Haas formed a partnership with Armstrong and Texas Steam to facilitate an auditing and repair program and bring a higher level of expertise to steam trap diagnostics, application, and installation.

A second audit conducted in September 2000 revealed that the steam trap program had reduced total steam losses by more than 50% to 44,000 pounds per hour.

Steam trap and leak repair work now continues at the Deer Park facility on a more routine basis. The most recent audit conducted in July 2002 showed that total steam losses from leaks and traps were down to 28,000 pounds per hour, nearly 70% less than when the program started in 1999. Figure 1 illustrates the improvements achieved by the program over the last three years. Through

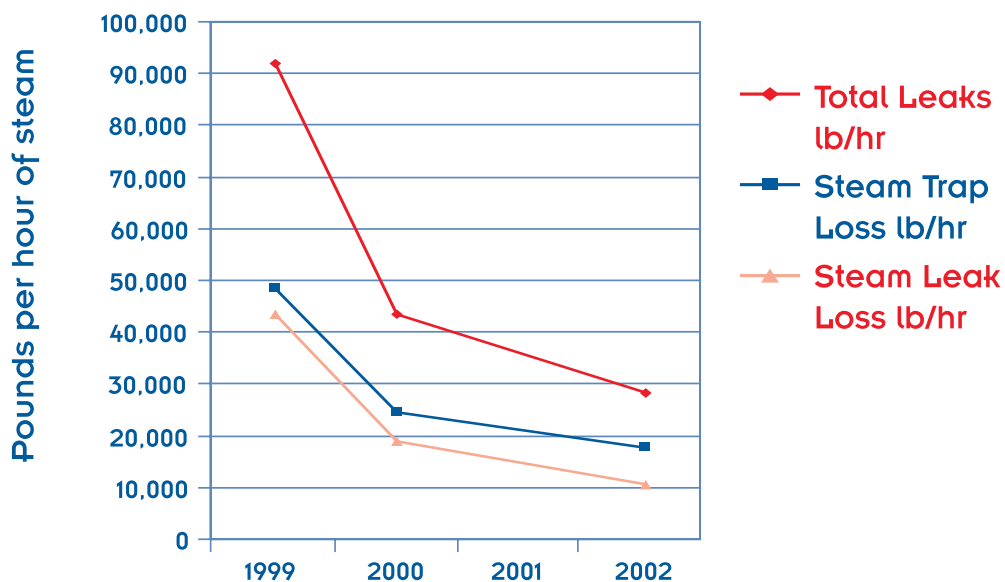
Benefits

- Substantial reduction in steam trap energy losses.
- Reduced steam production requirements.
- Lower steam trap failure rates.
- Improved capabilities for steam trap monitoring and maintenance.

maintenance and repair, steam trap-based failures have also decreased by nearly 20%.

Monitoring of steam traps and leaks involves annual testing of all the traps in the plant and subsequent recommendations for repair. Operations personnel conduct regular visual inspections of steam systems throughout the plant.

Figure 1: Steam Trap and Leak Audit Results



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Tracking and Reporting System

The steam trap program revealed that the methods formerly used to keep trap installation and repair records were inefficient and time consuming. To address this problem, the plant purchased a Trapbase2k system to help manage the steam trap program. Trapbase2k allows for data collection using a hand-held personal computer (PC) that can scan bar coding for trap identification. The field data downloads to a local PC with the Trapbase2k relational database software. The software is easy to use and allows for easy tracking and reporting of survey results, user-defined reports, and detailed historical and repair data.

Important Ancillary Results

The steam trap audit program revealed some interesting facts about the steam trap system. This knowledge can be incorporated to improve future steam trap design, installation, and maintenance.

- Less than half of the steam trap population was working as designed.
- Each subsequent survey finds additional traps—some traps were insulated, making them difficult to find.
- Based on the Deer Park trap population and failure rates, a trap can be expected to fail or a new leak to develop at a rate of one per day (excluding out-of-service traps).
- Bleed valves that are stuck partially open are a common occurrence.
- Higher-pressure systems represent a smaller portion of the population, yet have a higher proportion of losses and failure rates.

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